A free world education eBook

# CASEBOOK

OF

# BIBHAS DE

# RAINER

THE

# TOOLSHED TINKERER

For some fifty years, Rainer Weiss ruled the roost
over cosmology's experiment frontier (COBE, LIGO).
He approached his experiment design with
the fervor of a gadgeteer.
A one-trick pony, he wanted to do it every time
with light and mirrors.
With COBE, the light failed him.
With LIGO, the mirrors failed him.
In the ensuing dark, pounced on his shoulder
the toolshed monkey ...

# INTRODUCTION

On July 28, 2021, Rainer Weiss gave a talk at NASA-Ames. The blurb on him there says:

Dr. Weiss is known for his … roles as a co-founder and an intellectual leader of both the COBE (microwave background) Project and the LIGO (gravitational-wave detection) Project.

This is a good introduction to our discussion here. COBE and LIGO were very different projects: one directed at electromagnetic waves and the other gravitational waves. But they had two factors in common:

1. Rainer Weiss
2. Light-and-mirrors (Interferometry)

The history of the two projects suggests that the ideas incubated in Weiss' mind at about the same time. For many reasons, the use of interferometry for COBE was wrong. Another person without any preconceptions would most likely not even have considered it, or if he did, would have quickly dismissed it. So, COBE design was colored by Weiss' fascination with light and mirrors.

The cross-fertilization of COBE and LIGO designs was not beneficial for either. The emphasis needed to be on individual needs. Instead, nifty gadgetry seems to be the common guiding light. COBE was to trace out a neat skewed hill and LIGO was to tell a Scheherazade-like blackhole-merger tale. If COBE had aimed to measure a dozen spot frequencies reliably and LIGO had aimed at just detecting gravitational waves, they would be science. Failed science, but science.

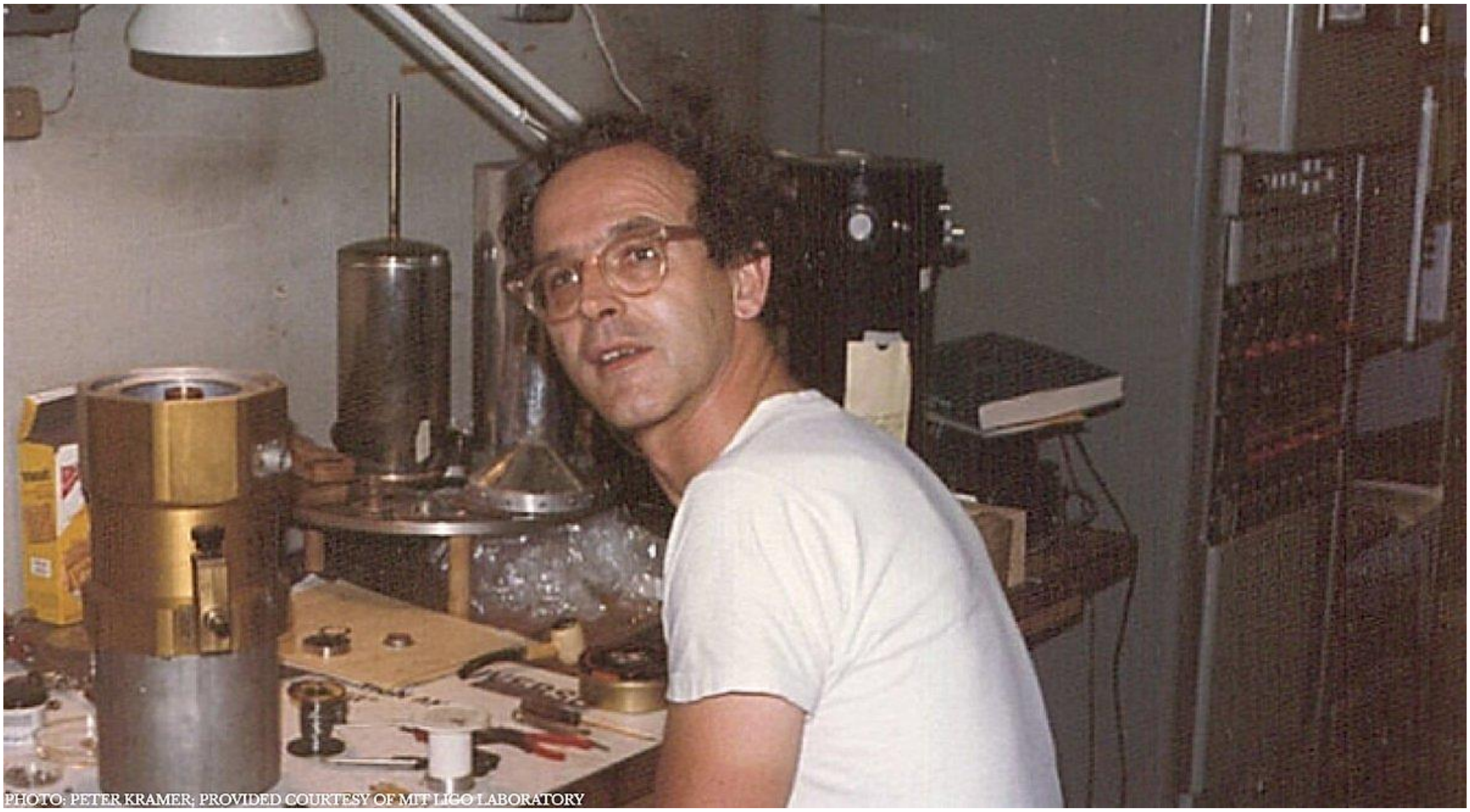
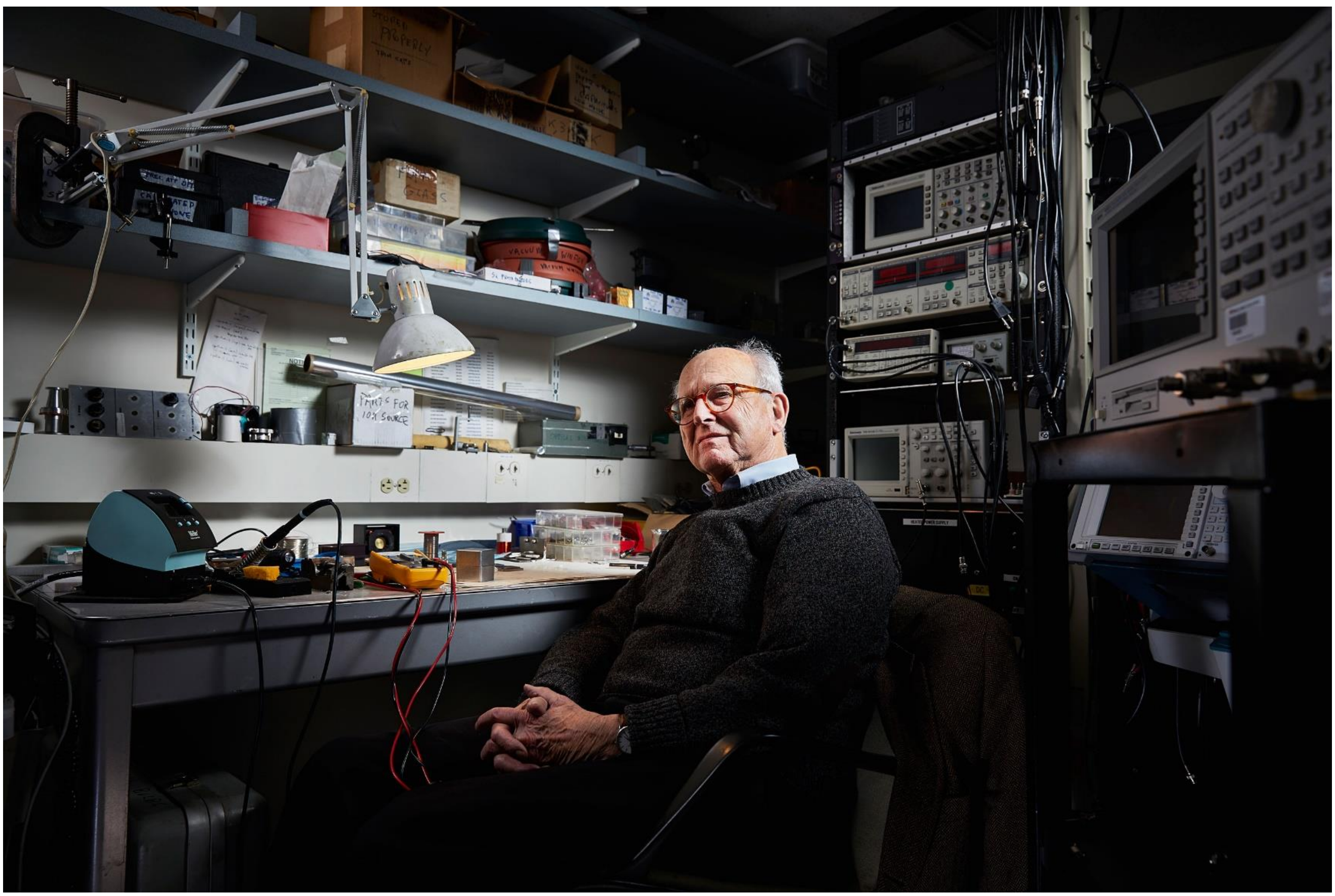


PHOTO: PETER KRAMER; PROVIDED COURTESY OF MIT LIGO LABORATORY



THE TOOLMAN IN HIS TOOLSHED

# PART I

# COBE AND LIGO:

# THE INNER RELATIONSHIP

# THE ROOTS OF LIGO

(The untold story behind 2017 Nobel Prize in Physics)

In the early 1960s, Princeton professor Robert Dicke was on a mission. One way or another, he would discover the predicted 3 K blackbody in the sky and clinch Big Bang Cosmology. He did not have to wait long. In 1964 he heard that two guys named Penzias and Wilson had observed an unexpected radiation component in the sky. It was an observation at a single frequency very far from the peak of the 3 K blackbody spectrum. No matter. Dicke got together with the two guys and passed this off as the discovery of the blackbody. The Nobel Prize followed for Penzias and Wilson in 1978.

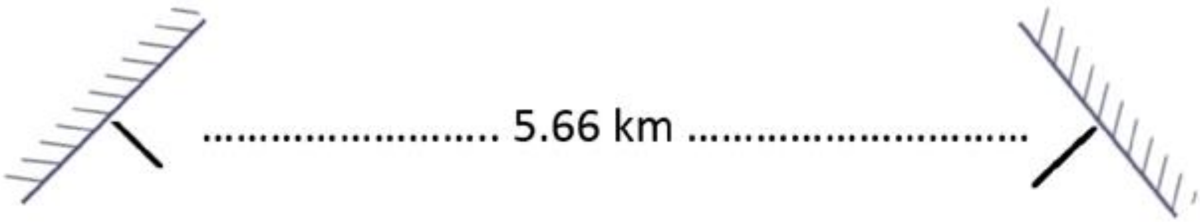
Robert Dicke had started a process to transform the physics establishment to where no one would notice the blatancy with which grand discoveries would be made.

Dicke accordingly had taken two other boys under his wings. The boy Rai would become the science leader of the COBE Satellite program. He greatly embellished the Guru's fraud and discovered the entire blackbody spectrum in the sky. The Nobel Prize for that discovery would follow in 2006. But Rai was not done.

In 1975, Rai and the other boy Kip would share a hotel room in Washington DC. That night around the minibar the fate of your Universe was sealed. Four decades later the LIGO discoveries started rolling out. The physics establishment was now an integral part of the blatant fraud. For they each had been cycled through a pod.

A world education message from Bibhas De 11/01/2017

# THE BARE-BONES LIGO DETECTOR




These two mirrors on a vast field hang freely from independent overhead support structures. Extreme care has been taken to see the mirrors are not mechanically linked in any way. They vibrate/jitter randomy on their own when there is earth tremor, when a vehicle is passing nearby, when an electromagnetic disturbance is incident, and so on.

When a gravitational wave (GW) comes down from the sky (vertically to the plane of the paper, say), GW theory says that the mirror oscillations become concerted. When one mirror moves forward along its axis, the other moves backward, and *vice versa*. It is as though there is an invisible mechanical entanglement of the mirrors. So this is the effect of the gravitational wave on the LIGO instrument. This concert is what LIGO needed to experimentally demonstrate as happening, if it was to be a detector of GW.

And that is precisely what LIGO cannot demonstrate experimentally. A cock-and-bull story has been made to cover up this fact, to bypass it, to shunt around it, to gloss over it, to not address it. If some Joe Blow brings this up, they ignore him using their establishment power, media power, and Nobel power.

In no way, shape or form is LIGO a detector of gravitational wave. It is a billion-dollar piece of junk that has been promoted as a work of great genius. The world has never seen anything like this.

# COMPARATIVE FRAUDOLOGY

## The discovery template scam:

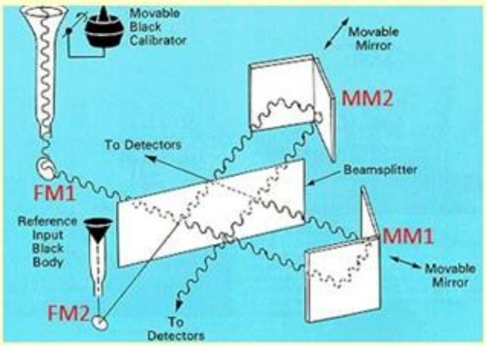
**It works on the "set a thief to catch a thief" principle. Rather than preserve the integrity of your precious data until the final observed result is obtained, contaminate the data with your discovery template at the very first step. Then pull out a signal that looks like your template.**

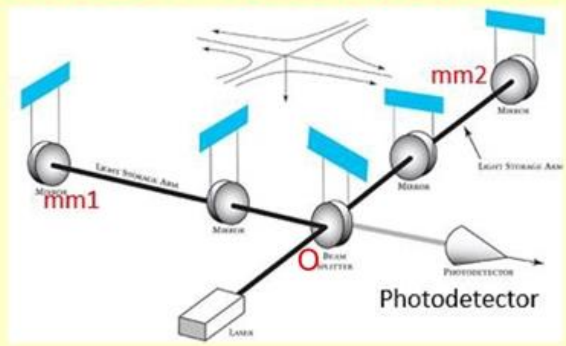
| | COBE Fraud | LIGO Fraud |
|---|---|---|
| SUBJECT: | BIG BANG COSMOLOGY | GEN. RELATIVITY |
| AGENCY: | NASA | NSF |
| COST: | $400 m | $1 bn |
| MANPOWER: | ~ 1000 | ~ 1000 |
| "DISCOVERED": | Cosmic Blackbody | Gravitational wave |
| INSTRUMENT: | Satellite in orbit | Observatory on ground |
| TECHNIQUE: | Interferometry | Interferometry |
| MOVING PART: | Mirrors, Calibrator | Mirrors |
| DATA DISPLAY: | Frequency domain | Time/Freq domain |
| FIX IS IN: | Onboard blackbody | Templating of pristine data |
| TEMPLATE: | Planck spectrum | Merging Black Holes |
| RESULT: | Uncanny agreement | Uncanny agreement |
| WAS THIS RESULT ON THE SKY? | No | No |
| INSTRUMENT SAW? | Sky | Geomagnetic disturbance |
| BUT WAS MADE TO REPORT: | Template | Template |
| SCIENCE LEADER: | Rainer Weiss | Rainer Weiss |
| WHERE WAS HE? | MIT | MIT |

A world education message from Bibhas De 09/05/2017

COBE AND LIGO BOTH USED INTERFEROMETRY.
COBE used microwave radiation; LIGO used laser light.
COBE was moving mirrors deliberately to make a frequency sweep: LIGO was trying to detect mirror movement.

## LIGO WAS NEVER AN INTERFEROMETER




In the 1970s and 1980s, Rainer Weiss was applying his legendary instrument genius to two interferometers in parallel: COBE (left) and LIGO. Raister hatched a plan.

We normally do not think of it this way, but the very first need of an interferometer is a fixed frame of reference, as with COBE (the moving mirrors MM1 and MM2 are referenced to the fixed mirrors FM1 and FM2.) LIGO has no such frame, and the mirrors mm1 and mm2 and everything else are moving when the wave passes by. The wavelength of laser run is changing in concord, and so even though the runs O-mm1 and O-mm2 are of unequal lengths, no interferometric phase lag results. So Raister spins this narrative: Forget wavelength; since the speed of light is constant within LIGO (he says), when the runs recombine at the photodetector, they have had different travel times. This *time* lag, Raister says, shows up as a *phase* lag (and hey presto, we are back to conventional interferometry!) Now see the graphic below which says this narrative is wrong. There is no phase lag in LIGO. *Interferometry never applied*. We only have the reckless mess of Rainer Weiss, and we're out $1.1 billion.

A world education message from Bibhas De 01/21/2019

**Duty to Inform**

From the history of the two projects, it appears that the idea of using interferometry first arose in the case of LIGO. After becoming deeply involved with this, Weiss may have caused or helped impose it on COBE. COBE discovery came in 1989, LIGO in 2015 (reported 2016).

# PART II

# WHY COBE INTERFEROMETER WAS A TOTALLY AVOIDABLE SCREW UP

The primary objective of the COBE Satellite mission was to confirm the presence in the sky of the ~ 3K cosmic blackbody radiation which was first discovered by Arno Penzias and Robert Wilson in 1964. However, these engineers made measurement at a single frequency (~ 4 GHz), and deduced from this the existence of an entire blackbody spectrum that peaked around 200 GHz. COBE then wanted to confirm the entire spectrum by broadband measurement. It was decided to employ an interferometry technique.

An interferometer at a simple level is light beams bouncing between mirrors. Right there, we have the very basic requirement: Light *beams*. We conclude immediately that there must be an issue called Beam Quality. And we can further guess that the beam must be well behaved. It must be of reasonably well-defined cross-section (as distinct from diffuse), and must not be converging or diverging. COBE did not meet even demonstrate this very first requirement in interferometry. But interferometry was done anyway. It was as though they had their mind set on it.

The 'interferometrized' COBE needed to collect radiation from the sky, convert it into a narrow beam and feed it to the interferometer. The frequencies involved were microwave (~ 30 – 300 GHz). Such radiation is normally collected with an antenna of a suitable type. However, there is no receiving antenna that outputs such a free-space beam of radiation. Therefore, the choice of doing

COBE with the interferometer meant saying goodbye to the entire realm of tried-and-true antenna technology and the well-developed science of antenna measurements. Thus, Weiss' love of interferometry may be what scuttled COBE completely from the get go.

What did they now do? Instead of an antenna, they chose a funnel-like device called a Winston Cone that collects radiation at the big end an delivers it at the small end in a somewhat concentrated form. When it emerges into free space from the back end, the radiation has some directionality. But it is by no means a beam. And furthermore, the phase relationship between the rays at the entry aperture plane have been randomized at the exit port plane. The Winston Cone was never meant to be applied to precision scientific measurements. It is in fact called a Heat Trap. You could may be use it effectively for solar cooking. To employ it for scientific measurements where extreme precision was called for is incomprehensible, for me anyway.

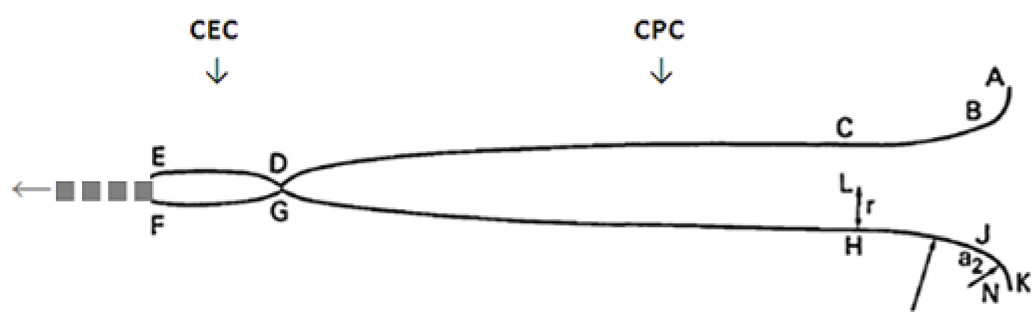


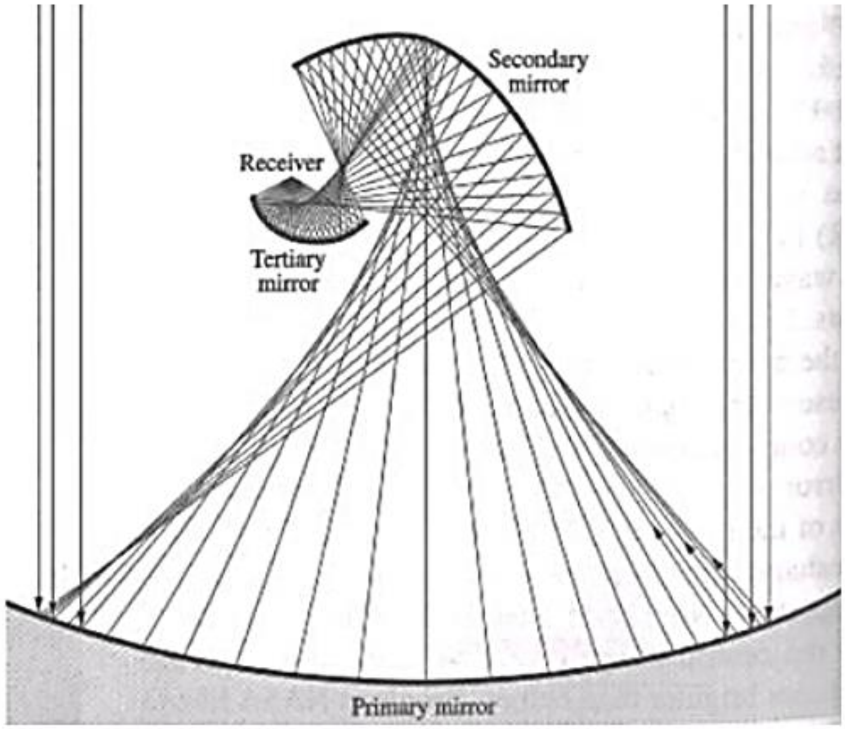

Figure IV-4: The FIRAS Sky Horn showing how a free space beam of radiation (grey dashes) emerges from its backport.

Now refer to this figure from my book *The Falsifiers of the Universe*. The CPC (Conical Parabolic Reflector, CDGH) is basically the Winston Cone with a flare section ACHK added at the front end (right). DG is the backport of the cone. The CEC (Conical Elliptic Concentrator) has been added in an attempt to turn the radiation coming through DG into a parallel beam exiting the contraption at EF as a free-space beam of radiation (indicated by grey bars). The various pieces were slapped together based on guesswork, without any rigorous scientific analysis (such as conventional geometric ray tracing.)

So, isotropic radiation enters at AK and some of it exits at EF as a free-space beam that then enters the interferometer (i.e. impinges on a 45-degree mirror.) What evidence is there that these grey bars represent a functional beam for an interferometer? Zero. Absolutely none. They are proceeding on a wing and a prayer.

Not only was there not offered any experimental test data to show this is a proper beam for interferometry. "Beam Quality" was never addressed in the published literature. Since the structure geometry is fully specified, it was very easy to do a geometric ray-tracing to show how isotropic radiation travels from right to left and emerges from the back. A fraction of a pack of rays incident at the aperture AK at random angles will emerge from the back port GH as a convergent or divergent or a parallel beam. This would be conclusive (parallel is what we want.) Here, for example, is one such calculation of

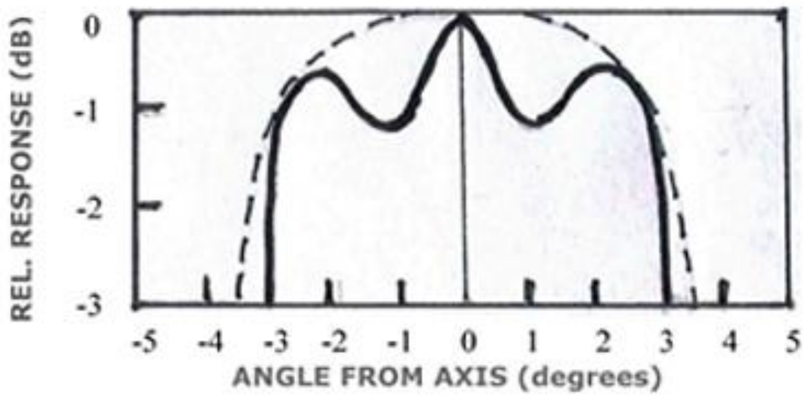
what happens to parallel rays incident on a telescope aperture. This is a standard procedure. In the case of COBE, this was a must. But they did not do this.




Geometrical optics ray tracing for the Arecibo radiotelescope

But this not all. The all-important pattern of the COBE “antenna” AEFK was totally shot to pieces in orbit. See figure below, from my book. The dashed pattern is what should have been, the broken pattern is what actually was. This is by far the single most important figure in the COBE Satellite project, but you will not find it anywhere except from me. This is not an error or acceptable variance. This was total failure.

This is where the COBE-FIRAS task *abend*ed. Everything that came afterwards was made out of whole cloth.




**BEAM PATTERN DETAIL:**
Dashed line: Ground measurement
Solid line: Orbital measurement
(Data source: NASA COBE Science Working Group)

This failure scuttled COBE all by itself, regardless of any other considerations. And remember that this is a consequence of deciding to go the interferometer route. Additionally, this crapping out of the pattern may have affected the interferometer beam quality further.

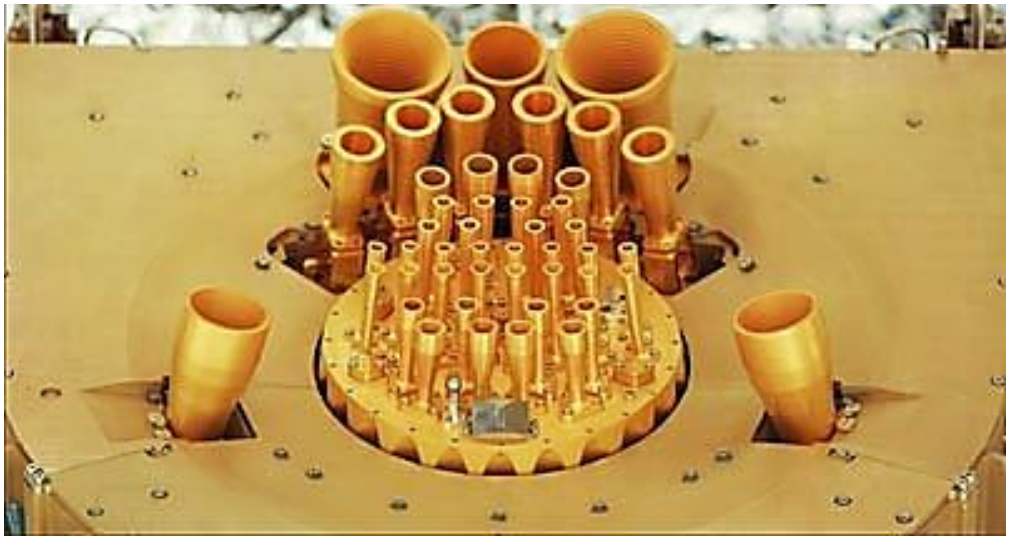
Let me mention something at this point. When you hear of the phenomenal exploits of NASA, these are largely exploits of the engineering companies that design and build the various components of a mission. NASA only manages. In the case of COBE, however, a rare decision (rare in the COBE era) was made to build the instrument inhouse. There was no involvement of any seasoned teams of engineers from any aerospace companies.

To summarize: The use of interferometry forced the use of the Winston Cone setup. The use of the Winston Cone presented multiple fatal problems. The antenna pattern was totally unusable, and the interferometer beam was totally uncharacterized. There was no science in it.

If, instead of forcing COBE to adapt to the choice of the interferometer, an *ab initio* decision was made whose goal was to maximize success of the mission, what should have been done?

First, you would go the antenna route where the science and the engineering are both established. But you need to make broadband measurements (~ 30 – 300 GHz) that would pin down the spectrum of a blackbody at ~ 3 K. You cannot cover such a broad frequency range with a single antenna. But you can with a single reflector and multiple focal plane feeds (which cover several single frequencies, each with high precision.) So, let us say you have a suitable reflector that covers the frequency band, and you use ten different feed horns at ten different frequencies at the (adjustable) focal point. You choose the ten frequencies strategically to convincingly establish whether or not the spectrum exists on the sky. Now, science-wise, there is nothing to go wrong and nothing is left to chance.

The Planck Satellite, which was launched some twenty years after COBE, used this solid design – even though it was not directed at measuring the blackbody. The point is that what I described above for COBE was completely doable, and a successful outcome (blackbody exists/does not exist) would have been nearly certain. Every information Planck had available, COBE also had available. Most any experienced engineer would have suggested the said design to COBE.



Planck satellite “antenna farm” at the focal point of a reflector antenna arrangement, consisting of precision-designed horns of different frequencies.

I believe COBE design was largely colored by Weiss’ preoccupation with interferometry. But the blame for pulling out a picture-perfect blackbody spectrum from this wreck belongs to John Mather. COBE Satellite could no more measure a spectrum on the sky than a ham sandwich in polar orbit could measure a spectrum.

# PART III

# WHY LIGO INTERFEROMETER WAS A TOTALLY AVOIDABLE SCREW UP

Now, the inception and the bulk of the LIGO design work was done by Rainer Weiss. That's why he got half the Nobel money. He worked out the interferometry, and added the necessary General Relativity (to the laser run), and the necessary Quantum Theory (to the mirror "displacement"). He has been categorically described as the inventor of LIGO Interferometer, and no one has disputed this. If he deserves the lion's share of the credit thus, that remains true when the credit turns to blame.

Rainer Weiss' completed idea was then sent to Kip Thorne for his evaluation and support. Thorne spent four years agonizing, then endorsed that whole Weiss package. You have to recall that Thorne is considered the top expert on General Relativity.

So, we have something designed with the fullest intellectual wherewithal of an instrumentation super-genius and a theory super-genius.

MEMORANDUM: LIGO INSTRUMENTATION FRAUD

## Apportionment of blame

There is now a clear statement (01/09/2018) from Kip Thorne accepting full responsibility for the instrument. So he and Rainer Weiss are equally to blame for the quack instrument concept that made the fraudulent grand discoveries.

**"TIMES OF INDIA: Were you always convinced about detections?**

Thorne: It's been a long journey, I began thinking about it about 50 years ago from a theoretical point of view, though it was 45 years ago when Rainer Weiss proposed the type of GW detectors we use in LIGO. It took me four years to get convinced that his design and idea has a serious chance to succeed, and once I was convinced I made a commitment to do everything to help him and his experimental colleagues to pull it off. I never had any serious doubts that this would succeed once I fully understood how this may work and the obstacles, and came to know the significant possibility to succeed."

According to theory, a GW sets the two LIGO mirrors (~5.6 km apart) in *concerted* motion. Since LIGO can never measure the absolute motion of each mirror, this GW *signature motion* can never be observed. LIGO senses only *differential* motion of the two mirrors. If the mirrors were initially stationary (no other sources of motion), and the LIGO readout suddenly showed a wiggle similar to that calculated for the GW signature motion, this wiggle still would not prove that this motion is taking place. As an example, the wiggle could be due to just one mirror moving or tilting or jittering due to some unknown impetus local to that mirror. Thus even this textbook-ideal LIGO cannot detect GW on paper. Simultaneous signals at two or more stations, or demonstrating wiggle-matching cannot confirm the GW signature motion.

**LIGO : GW :: Dowsing Rod : Water**

01/16/2018

The thing is, Weiss had got almost everything wrong. Every issue that was in uncharted territory and required true scientific depth and true scientific ideation, he got wrong.

Here is the real deal with the LIGO that thus resulted and the world knows today as the work of the highest minds: If every impetus were removed from LIGO, leaving it to respond only to gravitational waves, it would not provide any response as the wave passes by. The

interferometer’s photodetector sees zero light whether or not there is a gravitational wave.

This discussion is in two parts. First, my analysis shows that LIGO cannot respond to gravitational waves if the Thorne-Weiss application of GR to LIGO is correct. Second, some others show that the Thorne-Weiss interpretation of GR for LIGO is itself fundamentally wrong.

# PART IV

# WHY LIGO CANNOT RESPOND TO GRAVITATIONAL WAVE

1. General Relativity forces Thorne-Weiss LIGO interferometer arm length into the $L \ll \lambda_{gw}$ regime.
2. Wave physics excludes Thorne-Weiss LIGO interferometer arm length from the $L \ll \lambda_{gw}$ regime.

# LIGO PHYSICS FOR YOUR KIDS

OK kids, let's talk about the LIGO discovery machine. Let me explain this in words only – without figures and equations. Imagine a metal cross with two equal arms. Lay it down on a table. Now gravitational wave (GW) comes down on the table. The LIGO machine theory says that, at any given instant of time, the wave compresses one arm and stretches the other arm. So the equal-length arms become of unequal lengths. Let us call this phenomenon *a differential effect*. LIGO reportedly measures the nonzero difference in the two lengths, and from this difference, infers the presence of the GW and deduces its properties.

This theory misses entirely the wave nature of gravitational *wave*. There are two lengths to be considered: The length of the arm of the cross, and the wavelength of the GW. When the arm length is less than about one-third the wavelength, the cross cannot feel the differential effect. The change in lengths of the arms will be equal, and approach zero.

The basic physics of waves says that when a physical structure encountered by a wave is smaller than about one-third the wavelength, the wave cannot "resolve" the structure. What this means in plain language is that the GW does not see the cross as an oriented two-armed structure, but sees it as a fuzzy spot. In the case of LIGO, the cross is infinitely small compared to the wavelength, and so LIGO response can contain no information about GW even if it exists and the theory of the differential effect is correct.

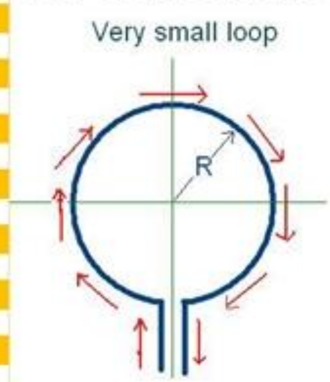
Clearly then, there is no way to salvage the LIGO machine. It is a billion-dollar piece of junk.

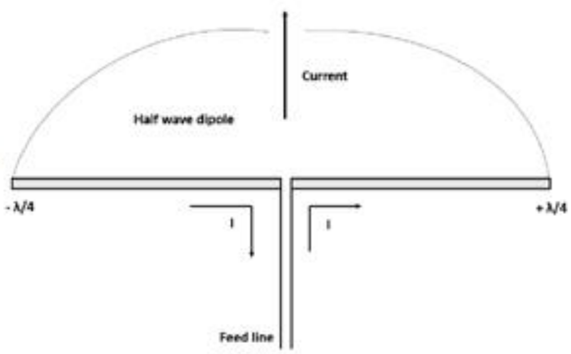
A world education message from Bibhas De 12/04/2018

# LIGO SCAMORAMA IX

## RAINER'S POLARIZATION

**Rainer Weiss of MIT was the science leader of the COBE Satellite program where the science concerned electromagnetic (EM) waves. In my 2015 book *The Falsifiers of the Universe* I showed how the entire program was based on gross misunderstanding of EM wave properties at many levels. One particular point had to do with total misconception about polarization. Where an unpolarized (randomly polarized) wave was flowing through a pipe of circular cross-section, they willy-nilly changed it into a rectangular cross-section prior to launch, without ever telling the scientific community. This introduced instrumental polarization where there was none on the sky. In retrospect, Weiss never understood anything about wave behavior in general – not just EM waves. His quackery carried over to LIGO.**




**In EM, a loop antenna, for example, whose size R is much smaller than the wave-length λ is callerd a probe. It can be used to sense the presence of a wave over a broad range of frequencies. It cannot give you the strength of the wave or its direction of travel or state of polarization.**

**A half-wave dipole on the other hand, for example, can give you the strength, the plane of polarization for linear polarization, and the approximate direction.**

**LIGO as a gravitational wave antenna is akin to a probe. It cannot work off the polarization of the wave or give you the strength. Every single one of the five LIGO discoveries is an elaborate fraud, just like the COBE and the BICEP2 discoveries.**

**The WMAP Satellite and the Planck Satellite covered up the COBE fraud. *The Physical Review Letters* and the European Space Agency helped cover up the BICEP2 fraud. Now the entire physics establishment is knowingly covering up the LIGO fraud.**

A world education message from Bibha De 11/04/2017

## Gut check

# LIGO SIZE vs WAVELENGTH

Consider Kip Thorne's teaching on the similarities and differences between electromagnetic and gravitational waves. This is germane to detection of the waves:

> The dominant mode of gravitational radiation is *quadrupolar:* it has a quadratic dependence on the positions of the generating charges, and causes a relative "shearing" of the positions of receiving charges. The dominant mode of electromagnetic radiation is *dipolar:* it has a linear dependence on the positions of the generating charges, and creates a relative translation of the positions of receiving charges.

Now, exactly what physics here exempts GW detectors ("receiving charges") from the fundamental limitation that EM wave detectors have? In the latter case a detector whose size is infinitely small compared to the wavelength would not be able to detect the wave at all. Even if it can sense the wave marginally, it would have no directionality at all. But LIGO detector which is 100-1000 times smaller than the wavelength can work fine off the polarization of the GW, which requires great directionality! No explanation has ever been given for this strange assertion about GW exceptionalism, as with many other strange LIGO physics assertions. LIGO cannot detect GW, period. Because of its great length, LIGO can detect all sorts of geomagnetic disturbances.

Kip Thorne has been laying a lot of sham physics on us from a platform of great authority.

**DUTY TO WARN**

A world education message from Bibhas De 05/07/2019

# LIGO SIZE vs WAVELENGTH

## How Kip Thorne shot himself in the foot

LIGO has three length parameters: the arm length L; the gravitational wave wavelength $\lambda_{gw}$, and laser wavelength $\lambda_{laser}$. Thorne adopted the design approach L « $\lambda_{gw}$, which was a fatal mistake because such a LIGO detector is insensitive to GW. However, LIGO is married to the condition L « $\lambda_{gw}$. The issue came up that just as L stretches and contracts as a GW passes through, so does $\lambda_{laser}$. As such, there would be no interferometric phase shift due to the GW. To this, Thorne replied:

"Does the wavelength of the light in the gravitational wave get stretched and squeezed the same manner as these mirrors move back and forth? ... The answer is no, the spacetime curvature influences the light in a different manner that it influences the mirror separations ... the influence on the light is negligible and it is only the mirrors that get moved back and forth and the light's wavelength does not get changed at all ...".

Valerio Faraoni (https://arxiv.org/pdf/gr-qc/0702079.pdf) elaborated that Thorne's thesis is true only when L « $\lambda_{gw}$ (in the following $\partial x = \Delta L$, the mirror displacement; $h_+$ is GW strain: $\lambda_{phys}$ is $\lambda_{laser}$, but a variable):

In the approximation $\lambda_{gw} \gg L$ the time dependence disappears and

$$\frac{\delta x}{L} = \frac{h_+(t=0)}{2} , \tag{4.2}$$

which is different from zero, while the percent variation of proper wavelength $\delta\lambda_{phys}/\lambda_{phys}$ for the laser light traveling in this arm is zero in this approximation.

Thorne's LIGO operation is restricted to the regime L « $\lambda_{gw}$, in which regime GW cannot be detected because of wave physics limitations.

A world education message from Bibhas De 05/09/2019

# LIGO WAVELENGTH-STRETCHING

*The issue:* As each LIGO arm of length L (=4 km) stretches/contracts by $\Delta L$ as a gravitational wave (wavelength $\lambda_{gw}$) passes through, so does the wavelength $\lambda_{laser}$ of laser light, at the same rate. What effect does this have on the interferometric phase shift $\Delta\phi$? LIGO affirms wavelength-stretching but says it has no effect on $\Delta\phi$.

Let us color a one-wavelength segment of the laser sine wave just as it leaves the beam splitter. The segment splits into two segments of half the power each, and travels along the two LIGO arms. Each will take a time-of-flight $T_{flight} = 2(L \pm \Delta L)/c$ to travel to its end mirror and return to the detector. When they meet here, they differ in phase by $\Delta\phi_1 = 2\pi(2\Delta L/\lambda_{laser})$ due to mirror "movements", and by $\Delta\phi_2 = 2\pi(2\Delta\lambda_{laser}/\lambda_{laser})$ due to wavelength change ($\Delta\lambda_{laser}$ is the change in $\lambda_{laser}$ due to wavelength-stretching.)

The change $\Delta L$ happens in a time $T_{gw}/4$ where $T_{gw}$ ($=\lambda_{gw}/c$) is the time period of GW. In each arm, our laser wave segment spends the time $T_{flight}$ during which it is shortened or lengthened. So, approximately

$$\Delta\lambda_{laser}/\Delta L \sim T_{flight}/(T_{gw}/4)$$

Or

$$\boxed{\Delta\lambda_{laser}/\Delta L \sim 8L/\lambda_{gw}}$$

When $L \ll \lambda_{gw}$, $\Delta\phi_1 \gg \Delta\phi_2$ and $\Delta\phi \approx \Delta\phi_1$. This may be the conceptual basis of the LIGO argument above. However, for LIGO $T_{flight}$ calculation, $L \sim 4\text{x}280$ km, and $\lambda_{gw}$ may be $\sim$ 1000 km, for example. Do the math!

Note that the segment can sequentially undergo both stretching and contraction, with an integral result $\Delta\phi_2$. Also relevant, some have said that the speed of light changes in the GW frame. LIGO says it does not.

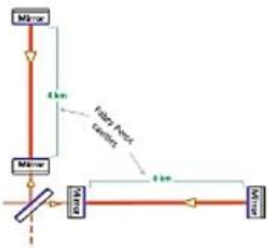
Bibhas De 05/16/2019

# LIGO SIZE vs WAVELENGTH

## More muddle

My previous graphic (see below) explained how Kip Thorne's LIGO operation is restricted by his theory to the regime L $\ll \lambda_{gw}$, in which regime, however, gravitational wave cannot be detected because of wave physics limitations. Here L is the length of the laser run (4 km), and $\lambda_{gw}$ is the wavelength of GW (~1000 km, for example).

However, there is another problem. The L for actual LIGO is not 4 km, but 4x280 km. Here is the reason:



This dilemma was fixed by adding something called "Fabry Perot cavities" to the basic Michelson design. The figure at left shows how a basic Michelson interferometer is modified to include Fabry Perot cavities. Compare this to the figure **above**.Each arm has a Fabry Perot 'cavity'. It is created by adding mirrors near the beam splitter that continually reflect parts of each laser beam back and forth within the 4 km long arms *about* *280 times* before they are merged together again.

So, the length of the laser run is comparable to $\lambda_{gw.}$ Thorne's theoretical criterion for LIGO operation to be valid was not applied to the actual LIGO discovery instrument. There may be other issues with this long a laser run.

Note however that this effective enlargement of the arm length does not help overcome the wave physics limitation (that LIGO cannot observe GW with L $\ll \lambda_{gw}$.) There, L refers to the *physical size* of the LIGO arm (4 km).

A world education message from Bibhas De 05/13/2019

# LIGO GRAVITATIONAL WAVE DISCOVERY REAFFIRMED BY

PERIMETER INSTITUTE

PRINCETON

Ace data analysts at Perimeter Institute have *independently* confirmed LIGO discoveries. A fully vindicated Frans Pretorius of Princeton said that for more than a year, he and most of the physics community has been satisfied that "LIGO analysis, and its discovery, are sound." Now folks, here's little mundane *hoi polloi* physics for your consideration:

**Displacement produced by GW, $\Delta x \sim 10^{-19}$ m**

**After amplification (x300) by LIGO, $\Delta x' \sim 10^{-16}$ m**

**LIGO laser wavelength, $\lambda \sim 10^{-6}$ m**

So, the phase shift produced by GW between the two laser runs at the LIGO detector face:

$$\Delta\phi \sim 360\,(\Delta x'/\lambda) \sim 3.6 \times 10^{-8} \text{ degree}$$

$$\text{LIGO GW signal strength} \sim \sin^2(\Delta\phi) \equiv 0$$

The minimum detectable phase shift in laser interferometry is ~ 1 degree. How can one tease out of the LIGO data stream a picture perfect gravitational wave on the sky when the instrument on the ground has not detected any?

A world education message from Bibhas De 12/15/2018

**Duty to Inform**

# PART V

# THORNE-WEISS GENERAL RELATIVITY INTERPRETATION FOR LIGO IS WRONG

(The entire paper is placed in the appendix)

Correct application of General Relativity to LIGO shows that all the things that happen when a gravitational wave passes through LIGO together cause the interferometer light sensor to remain permanently dark.

# ONE BILLION DOLLARS FOR THIS?!


The LIGO instrument operates strictly on the principle that while a gravitational wave is passing by, the speed c of the laser light remains a constant in that frame. In the following the authors explain with total clarity why this principle is wrong. Many others have explained many other fatal faults of LIGO. What no one can explain is why the Ligonauts are still peddling their wares and why goverments are still buying their wares. May be a taxpayer can ask France Córdova (above) or Diane Souvaine or Anneila Sargent.

## LIGO Experiments Cannot Detect Gravitational Waves by Using Laser Michelson Interferometers

### —Light's Wavelength and Speed Change Simultaneously When Gravitational Waves Exist Which Make the Detections of Gravitational Waves Impossible for LIGO Experiments

**Xiaochun Mei[1], Zhixun Huang[2], Policarpo Yōshin Ulianov[3], Ping Yu[4]**

*Journal of Modern Physics, 2016, 7, 1749-1761*

In the gravitational field, we have two definitions for ruler and clock, i.e., coordinate ruler and coordinate clock, as well as standard ruler and standard clock (or proper ruler and clock). Coordinate ruler and coordinate clock are fixed at a certain point of gravitational field. They vary with the strength of gravitational field. Standard ruler and standard clock are fixed on the local reference frame which falls free in gravitational field. In local reference frame, gravitational force is canceled, so standard ruler and standard clock are unchanged.

In LIGO experiments, observers are located at a gravitational field caused by gravitational wave, rather than falling free in gravitational field, so what they used were coordinate ruler and coordinate clock. Therefore, light's speed in LIGO experiments is not a constant.

01/23/2019

# PART VI

# COBE AND LIGO:

# ROOT LEVEL MISUNDERSTANDING OF ANTENNA/DETECTOR CONCEPTS

A root-level lack of understanding of how an antenna - acting as a detector (i.e. in reception) – functions, characterized both COBE and LIGO.

In the case of COBE-FIRAS, John Mather was primarily responsible for the antenna task, but Rainer Weiss was in overall charge of science. Whatever happened, Weiss had to have endorsed it. In the case of LIGO, Weiss was the principal.

In the case of LIGO, Weiss was 100% responsible.

You follow a wave (electromagnetic or gravitational) along its path. The wave hits the detector. What happens from then on? How should you design the detector so that this wave will engage with it through processes that are fully understood? This last question is answered wrongly in both COBE and LIGO inceptions.

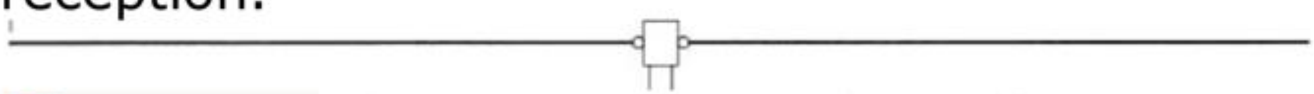
In the case of COBE, the concept of the Winston Cone or Heat Trap was mixed up with antenna concepts in a bungling way. The whole receiving system from the open sky to the input of the interferometer was an electromagnetically uncharacterized package. As we have seen, it failed completely once in orbit.

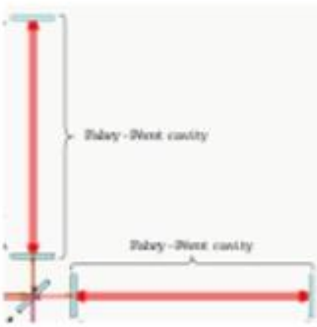
The LIGO L-shaped “antenna” is said to work off the polarization of the gravitational wave when in fact the polarization is a conjecture about the unknown wave which is to be discovered. Plus, even if the polarization were there, LIGO would not be able to work off it because of its size vs the wavelength of gravitational wave.

# Gut check Part II

# LIGO SIZE vs WAVELENGTH

Consider an electromagnetic wave detector (a dipole along x axis) and a gravitational wave detector (LIGO along x and y axis.) The EM wave or GW propagates along the z direction. Thus, the wavelength $\lambda$ is a variation in the z direction. So, one may have difficulty seeing how $\lambda$ figures in the detection process, when an antenna is in reception.

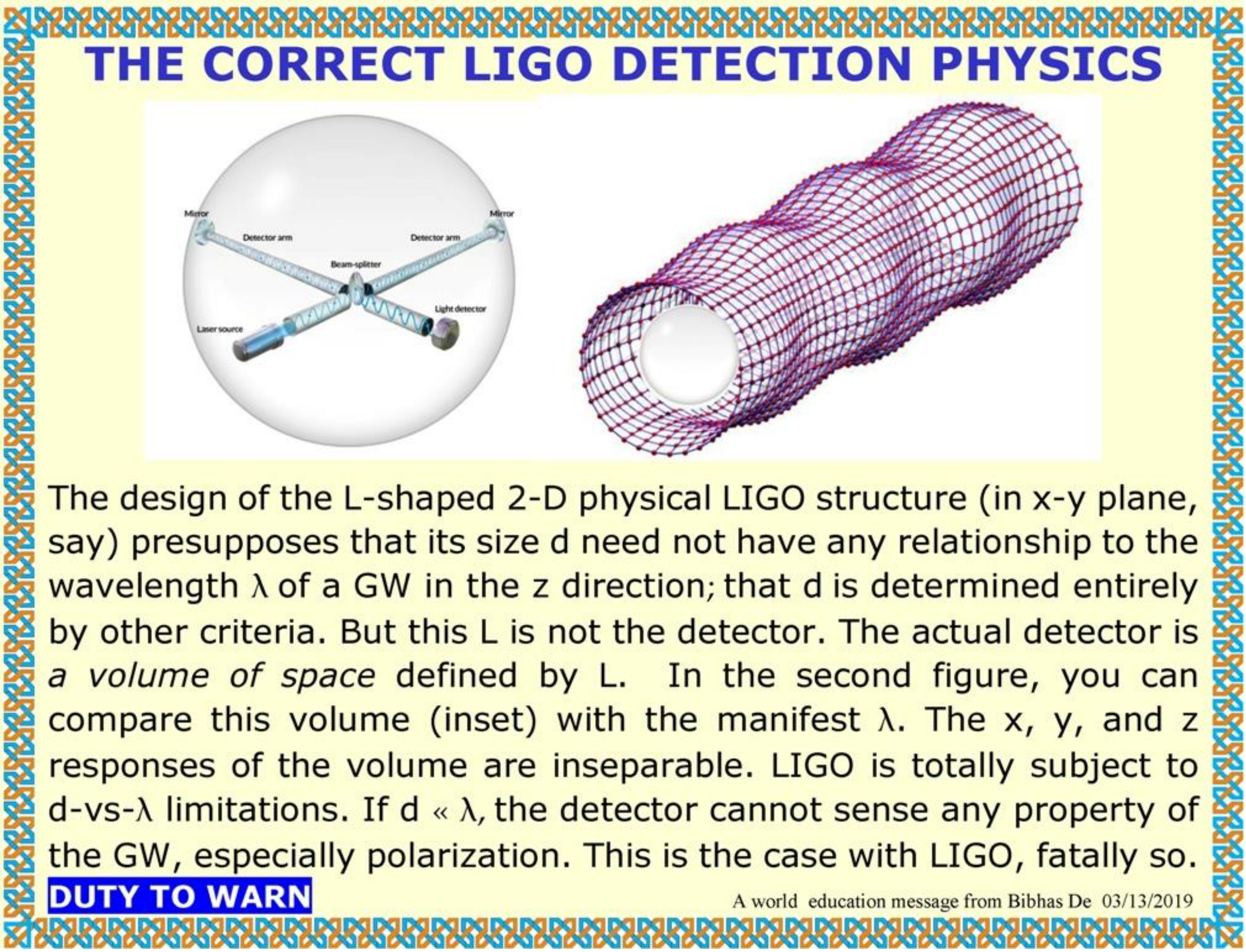




The EM antenna physically is a one-dimensional thing. But when it is in reception, its effective extent is a volume around it that contains non-radiating EM field. The size of this volume is dependent on the wavelength. This is how EM wave detection is dependent on $\lambda$.

For LIGO, it makes no physics sense to say the detector plane is infinitely thin and is not affected by what happens ahead of it and behind it the z direction. The effective detector is a volume of space (or spacetime) around the LIGO arms. (i.e. LIGO response depends on how the strain falls off or rises away from this plane in the z direction.) This is how GW detection is dependent on $\lambda$.

The second – and perhaps more important – misunderstanding is described in the following figure:




For these reasons, neither COBE nor LIGO was a scientific instrument. They could never have scientifically made the discoveries that were reported. The discoveries were owed largely to the work of a toolshed tinkerer with a MIT PhD.

# PART VII

# WHAT DID THE MONKEY SIGNIFY?

The classic horror story *Green Tea* by Sheridan Le Fanu is on the surface about a spectral monkey terrorizing a scholarly clergyman who consumes too much green tea. Every place the Reverend goes, the monkey appears. Deep down, it may really be a story about the man’s own inner conflict.

# THE LIGO HORROR

## RAINER WEISS AND HIS MONKEY: A *GREEN TEA* STORY!

I feel an enormous sense of relief and some joy, but mostly relief. There's a monkey that's been sitting on my shoulder for 40 years, and he's been nattering in my ear and saying, "Ehhh, how do you know this is really going to work? You've gotten a whole bunch of people involved. Suppose it never works right?" And suddenly, he's jumped off. It's a huge relief.

In a later interview:

I feel like a monkey just jumped off my back! But the monkey's not gone yet, he's still walking along here on the sidewalk.

*Rainer Weiss on the LIGO discovery*

After all is said, all discoveries are done, all prizes are in the bag, all is enshrined in brass plaques or streetside statues, all the knowledge is installed in children's mind, all the museum exhibits have been arranged,

what is this about?!

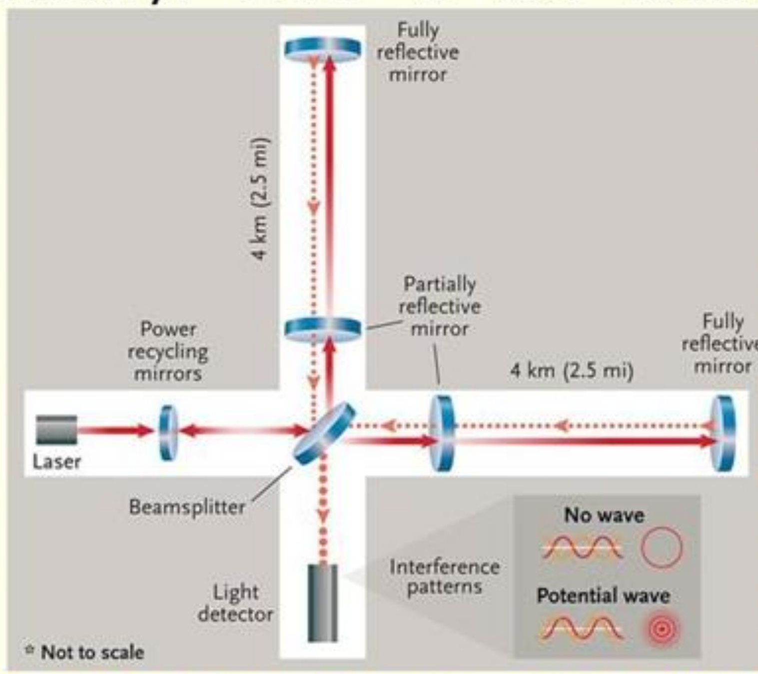
Isn't this a wee bit late?

I see, the monkey nattering in the ears again!

(See following graphic)

# RAINER WEISS REWORKS LIGO

Listen closely to any talk of modifying LIGO. They may "upgrade" their way out of a crappy instrument, and bury the evidence. This is what was done with BICEP2, without ever admitting the quackery. Here is the LIGO interferometry scheme. For it to function, all the laser paths (forward and return) must be active. If LIGO is successful, there should never be any need to tinker with these paths especially. Any such tinkering has to be to fix some screw up without admitting it.




"You cut the laser off at the first mirror, and that solves one of the problems. It allows you to change the way the interferometer behaves in relation to a gravitational wave." - Rainer Weiss, 25 April 2019, at UT Austin

Assuming 'first mirror' means one of the two end mirrors (the other mirrors are not relevant to LIGO theory), you no longer have an interferometer when you "cut off" the laser beam there (or anywhere else). It is like extinguishing the Jedi lightsaber. The resulting dud instrument can detect nothing about how "the interferometer behaves …" Rainer Weiss the LIGO inventor today sees "problems" with LIGO. He wants to fix them by extinguishing LIGO. He was screwing around then. He's screwing around now.

Bibhas De 05/02/2019

# APPENDIX

Journal of Modern Physics > Vol.7 No.13, September 2016

## LIGO Experiments Cannot Detect Gravitational Waves by Using Laser Michelson Interferometers—Light's Wavelength and Speed Change Simultaneously When Gravitational Waves Exist Which Make the Detections of Gravitational Waves Impossible for LIGO Experiments

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### Abstract

It is proved strictly based on general relativity that two important factors are neglected in LIGO experiments by using Michelson interferometers so that fatal mistakes were caused. One is that the gravitational wave changes the wavelength of light. Another is that light's speed is not a constant when gravitational waves exist. According to general relativity, gravitational wave affects spatial distance, so it also affects the wavelength of light synchronously. By considering this fact, the phase differences of lasers were invariable when gravitational waves passed through Michelson interferometers. In addition, when gravitational waves exist, the spatial part of metric changes but the time part of metric is unchanged. In this way, light's speed is not a constant. When the calculation method of time difference is used in LIGO experiments, the phase shift of interference fringes is still zero. So the design principle of LIGO experiment is wrong. It was impossible for LIGO to detect gravitational wave by using Michelson interferometers. Because light's speed is not a constant, the signals of LIGO experiments become mismatching. It means that these signals are noises actually, caused by occasional reasons, no gravitational waves are detected really. In fact, in the history of physics, Michelson and Morley tried to find the absolute motion of the earth by using Michelson interferometers but failed at last. The basic principle of LIGO experiment is the same as that of Michelson-Morley experiment in which the phases of lights were invariable. Only zero result can be obtained, so LIGO experiments are destined failed to find gravitational waves.

**Keywords**
Gravitational Wave, LIGO Experiment, General Relativity, Special Relativity, Michelson Interferometer, Michelson-Morley Experiment, GW150914, WG151226

## 1. Introduction

February 11, 2016, LIGO (Laser Interference Gravitational-Waves Observatory) announced to detect gravitational waves events GW150914 [1] . Four months later, they announced to detect another two gravitational events WG151226 and LVT151012 [2] . In LIGO experiments, Michelson laser interferometers were used. Based on general relativity, we proved strictly that by using Michelson interferometers, LIGO cannot detect gravitational waves. The basic principle of LIOGO experiment is wrong. The so-called detections of gravitational waves and the observations of binary black hole mergers are impossible.
The design principle of LIGO experiments is as follows. According to general relativity, gravitational waves stretch and compress space to change the lengths of interferometer's arms. When two lights travelling along two arms which are displaced vertically meet together, the shapes of interference fringes will change. Based on this phase shifts, gravitational waves can be observed.
There are two methods to calculate the phase shift of interference fringes in classical optics. One is to calculate the phase difference of two lights and another is to calculate the time difference of two lights when they arrive at the screen. In LIGO experiments, two of them were used. But the calculations are based on a precondition, i.e., light's speed is a constant.
As well-known, light's phase is related to its wavelength. The stretch and squeeze of space also cause the change of light's wavelength and affect phases. However, LOGO experiment neglected the effect of gravitational wave on the wavelength of light. If the effects of gravitational wave on light's wavelength and interferometer arm's lengths are considered simultaneously, light's phases are unchanged in Michelson interferometers. So it is impossible for LIGO experiments to detect gravitational waves.
On the other hand, light's speed was considered as a constant in LIGO experiments. It is proved strictly based on general relativity that when gravitational waves exist, light's speed is not a constant again. If light's speed is less than its speed in vacuum when it travels along one arm of interferometer, its speed will be great than its speed in vacuum when it travels along another arm, i.e., so-called superluminal motion occurs. In this way, no time differences exist when two lights meet together in Michelson interferometer. Therefore, according to the second method of calculation, LIGO experiments did not detect gravitational waves too.
The other principle problems existing in LIGO experiments are briefly discussed in this paper. The conclusion is that LIGO experiments do not detect gravitational waves and no binary black hole mergers are observed. The signals occurred in LIGO experiments could only be noises caused by some occasional reasons.

## 2. Light's Phase Difference Is Invariable in LIGO Experiments

According to general relativity, under the condition of weak field, the metric tensor is

$$g_{\mu\nu}(x) = \eta_{\mu\nu} + h_{\eta\nu}(x) \quad (1)$$

Here $\eta_{\mu\nu}$ is the metric of flat space-time and $h_{\mu\nu}(x)$ is a small quantity. Substitute (1) in the Einstein's equation of gravitational field, it can be proved that the modal of gravitational radiation is quadrupole moment. In a small region, we may assume $h_{\eta\nu}(x) = h_{\eta\nu}(t)$. When gravitational wave propagates along the x-axis, the intensity of gravitational field is $h_{11}(t)$. While it propagates along the y-axis, the intensity is $h_{22}(t)$. It can be proved to have relation $h_{11}(t) = -h_{22}(t)$ [3] .

On the other hand, according to general relativity, we have $\mathrm{d}s^2 = 0$ for light's motion. Suppose that gravitational wave propagates along the z-axis, when lights propagate along the x-axis and the y-axis individually, we have [4]

$$\mathrm{d}s^2 = c^2\mathrm{d}t^2 - \left[1 + h_{11}(t)\right]\mathrm{d}x^2 = 0 \quad (2)$$

$$\mathrm{d}s^2 = c^2\mathrm{d}t^2 - \left[1 + h_{22}(t)\right]\mathrm{d}y^2 = 0 \quad (3)$$

It is obvious that time is flat but space is curved according (2) and (3). The propagation forms of light are changed when gravitational waves exist. Due to $|h_{11}| \ll 1$, $|h_{22}| \ll 1$ and $h_{11}(t) = -h_{22}(t)$, we have

$$\mathrm{d}x = \frac{c}{\sqrt{1+h_{11}}}\mathrm{d}t = c\left(1 - \frac{1}{2}h_{11}(t)\right)\mathrm{d}t \quad (4)$$

$$\mathrm{d}y = \frac{c}{\sqrt{1+h_{22}}}\mathrm{d}t = c\left(1 + \frac{1}{2}h_{11}(t)\right)\mathrm{d}t \quad (5)$$

LIGO experiments used Michelson interferometers to detect gravitational waves. The principle of Michelson interferometer is shown in Figure 1. Light is emitted from the source S and split into two beams by beam splitter O. Light 1 passes through O, arrives at reflector $M_1$ and is reflected by $M_1$ and O, then arrived at E. Light 2 is reflected by

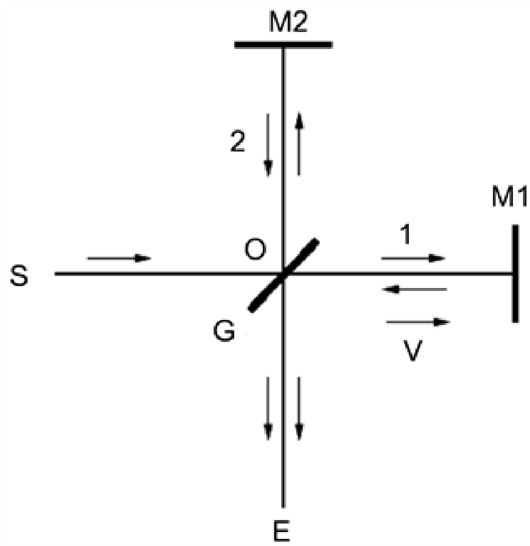


**Figure 1**. The principle of Michelson interferometers.

O, arrives at $M_2$ and is reflected, then arrived at E too. Two lights overlay and form interference fringes which can be observed by observer at E.

In order to reveal the problems of LIGO experiments clearly, we discuss the simplest situation. Suppose that the length of interferometer's arm is $L_0$ and let $h_{11}(t) = h$ = constant. The time interval is $t_2 - t_1 = 2\tau$ when the light moves a round-trip along the arm. The integral of (4) and (5) are

$$x = 2L_0(1 - h/2),\ \ y = 2L_0(1 + h/2) \quad (6)$$

Here $L_0 = c\tau$. So the optical path difference is $\Delta L = y - x = 2L_0 h$ for lights move along two interferometer's arms. Suppose that the electric fields of lasers are

$$E_x = E_0\cos(\omega t - kx),\ \ E_y = E_0\cos(\omega t - ky) \quad (7)$$

Here, $k = 2\pi/\lambda$, $\omega = 2\pi\nu$ and $\nu\lambda = c$. According to classical optics, by adding two amplitudes together directly and taking square, we obtain light's intensity which is unrelated to time

$$E^2 = \left(E_x + E_y\right)^2 = 2E_0^2\left(1 + \cos\Delta\delta\right) \quad (8)$$

The difference of phases is

$$\Delta\delta = k(y-x) = \frac{2\pi}{\lambda}(y-x) \quad (9)$$

If there is no gravitational wave, we have $y = x = 2L_0$ and get $\Delta\delta = 0$. If there is a gravitational wave which passes through the interferometers, according to the current theory, the difference of phases is

$$\Delta\delta = \frac{2\pi}{\lambda}(y-x) = \frac{4\pi L_0 h}{\lambda} \neq 0 \quad (10)$$

Therefore, gravitational waves would cause the phase changes of interference fringes. By observing the change, gravitational waves would be detected.

However, the calculation above has serious defects. At first, according to general relativity strictly, the formulas (1) and (2) are only suitable for two particles in vacuum without the existence of electromagnetic interaction. In LIGO experiments, two mirrors are hanged in interferometers using fiber material. Interferometers are fixed on the steal tubers which are fixed on the surface of the earth. Whole system is controlled by electromagnetic interaction. As we known, the intensity of electromagnetic interaction is $10^{40}$ times greater than gravitational interaction. Therefore, gravitational waves cannot overcome electromagnetic forces to change the length of interferometer's aims or make two mirrors vibration by overcoming the stain forces acted on fiber material. This is just the reason why J. Weber's gravitational wave experiments failed. This is the critical defect of LIGO experiments. We have discussed this problem in Document [5] , so we do not discuss it any more here.

Second, the major point in this paper is to emphasize that the effect of gravitational wave on the wavelength of light has not been considered in LIGO experiments. In fact, if gravitational wave causes the change of spatial distance, it also causes the change of light's wavelength. Both are synchronous. According to (6), when gravitational waves exist, the wavelengths of lights should become

$$\lambda_x = \lambda(1-h/2), \ \ \lambda_y = \lambda(1+h/2) \quad (11)$$

when two lights meet together, the difference of phases should be

$$\Delta\delta = 2\pi\left(\frac{y}{\lambda_y} - \frac{x}{\lambda_x}\right) = 2\pi\left(\frac{2L_0}{\lambda} - \frac{2L_0}{\lambda}\right) = 0 \quad (12)$$

Therefore, interference fringes are unchanged. That is to say, it is impossible to detect gravitational waves by using Michelson interferometers. If $h_{11}(t) \neq \text{constant}$, we write it as

$$h_{11}(t) = h\sin(\Omega t + \theta_0) \quad (13)$$

Here, $\Omega$ is the frequency of gravitational wave. Substitute (13) in (5) and (6), the integrals become

$$x = 2c\tau - \frac{ch}{2}\int_0^{2\tau} \sin(\Omega t + \theta_0)\,\mathrm{d}t$$

$$= L_0 - \frac{ch}{2\Omega}\left[\cos(2\Omega\tau + \theta_0) - \cos\theta_0\right] = L_0(1 - A/2) \quad (14)$$

$$y = 2c\tau + \frac{ch}{2}\int_0^{2\tau} \sin(\Omega t + \theta_0)\,\mathrm{d}t$$

$$= L_0 + \frac{ch}{2\Omega}\left[\cos(2\Omega\tau + \theta_0) - \cos\theta_0\right] = L_0(1 + A/2) \quad (15)$$

Here

$$A = \frac{ch}{\Omega L_0}\left[\cos\left(2\Omega\tau + \theta_0\right) - \cos\theta_0\right] \quad (16)$$

The result is the same with (6) by substituting A for h.

In LIGO experiments, by assuming that gravitational wave's speed is light's speed in vacuum, the frequency of gravitational wave is $\nu = 30 \sim 300\ \text{Hz}$ and the wavelength is $\lambda = c/\nu = 3\times10^6\ \text{m}$. The length of interferometer's arm is $L_0 = 4\times10^3\ \text{m}$, so we have $\lambda \gg L_0$. In the extent of interferometer size, the wavelength of gravitational wave can be considered as a fixed value. The formula (11) is still suitable by substituting A for h. So, even though (13) was used to describe gravitational waves, LIGO experiments could not detect gravitational waves too.

## 3. Light's Speed Is Not a Constant When Gravitational Waves Exist

Based on (4) and (5), we can obtain an important conclusion, i.e., light's speed is not a constant again when gravitational waves exist

$$V_x = \frac{dx}{dt} = \frac{c}{\sqrt{1+h_{11}}} \approx c\left(1 - \frac{1}{2}h_{11}\right) \neq c$$

$$V_y = \frac{dy}{dt} = \frac{c}{\sqrt{1+h_{22}}} = c\left(1 + \frac{1}{2}h_{11}\right) \neq c \quad (17)$$

This result also causes a great effect on LIGO experiments. The current theory always considers light's speed to be a constant in gravitational fields. According to Reference [4] , (17) means that the spatial refractive index becomes $1 + h_{kk}/2$ from 1 due to the existence of gravitational waves. In this medium space, light's speed is changed. More interesting is that if $h_{11} > 0$, we have $V_x < c$ and $V_y > c$. That is to say, $V_y$ exceeds light's speed in vacuum. How do we explain this result? No one consider this problem at present.

Reference [4] also indicates that "For Gaussian beam, the interval of space-time is not equal to zero. In the laser detectors of gravitational waves, Gaussian beams are used. Do these lights exist in curved space-time?" [4] . According to strict calculation, when gravitational waves exist, the propagation speed of Gaussian beam is

$$V_c = c\left|1 - \frac{2}{\left(k\omega_0\right)^2 + \left(2z/\omega_0\right)^2}\right| < c \quad (18)$$

Here, $\omega_0^2$ is the spot size of Gaussian beam, k is the absolute value of wave's vector and z is the coordinate of light beam. These results will cause great influence on the waveform match in LIGO experiment. The original matching signals would become mismatching when comparing them with the templates of waveforms. The conclusion to detect gravitational waves should be reconsidered.

In fact, LIGO team also admits that gravitational wave changes light's wavelength. In the LIGO's FAQ page (https://www.ligo.caltech.edu/page/faq) we can see the following question:

"If a gravitational wave stretches the distance between the LIGO mirrors, doesn't it also stretch the wavelength of the laser light?"

The answer of LIGO team is:

"A gravitational wave does stretch and squeeze the wavelength of the light in the arms. But the interference pattern doesn't come about because of the difference between the length of the arm and the wavelength of the light. Instead it's caused by the different arrival time of the light wave's "crests and troughs" from one

arm with the arrival time of the light that traveled in the other arm. To get how this works, it is also important to know that gravitational waves do NOT change the speed of light.
The answer is very confusing, showing that they aware of the problem but try to escape from it. Then they say
"But the interference pattern doesn't come about because of the difference between the length of the arm and the *wavelength* of the light."
The sentence makes no sense. In the above explanation, we see that
"Instead it's caused by the different arrival time of the light wave's 'crests and troughs' from one arm with the arrival time of the light that traveled in the other arm. To get how this works, it is also important to know that gravitational waves do NOT change the speed of light."
In this sentence, LIGO emphases that gravitational waves do not change light's speed. This is the foundation of LIGO experiments. Because this conclusion does not hold, LIGO's explanation is untenable.
It is a confused problem for many physicists whether or not light's speed is a constant in gravitational field. To measurement speed, we first need to have unit ruler and unit clock. According to general relativity, gravitational field cause space-time curved. In the gravitational field, we have too definitions for ruler and clock, i.e., coordinate ruler and coordinate clock, as well as standard ruler and standard clock (or proper ruler and clock). Coordinate ruler and coordinate clock are fixed at a certain point of gravitational field. They vary with the strength of gravitational field. Standard ruler and standard clock are fixed on the local reference frame which falls free in gravitational field. In local reference frame, gravitational force is canceled, so standard ruler and standard clock are unchanged.

It has been proved that if the metric tensor $g_{0i}$ which is related to time is not equal to zero, i.e., $g_{0i} \neq 0$, no matter what ruler and clock are used, light's speed is not a constant. If $g_{0i} = 0$, by using coordinate ruler and coordinate clock, light's speed is not a constant. Using standard ruler and standard clock, light's speed becomes a constant. But in this case, the observer is also located at the reference frame which falls free in gravitational field [3] .
In LIGO experiments, observers located at a gravitational field caused by gravitational wave, rather than falling free in gravitational field, so what they used were coordinate ruler and coordinate clock. Therefore, light's speed in LIGO experiments are not a constant. In fact, according to (2), the time part of metric is flat and the spatial part is curved, so the speed $V_x = \mathrm{d}x/\mathrm{d}t$ is not a constant certainly.
According to this definition, by using coordinate ruler and coordinate clock, light's speeds in gravitational fields are generally less its speed in vacuum. For example, light's speed is $V_r = \mathrm{d}r/\mathrm{d}t = c\left(1-\alpha/r\right) < c$ in the gravitational field of spherical symmetry according to Schwarzschild metric and $V_r = c\sqrt{1-kr^2}\big/R < 1$ at present moment with $R = 1$ in the gravitational field of cosmology according to the R-W metric. But in the early period time of cosmos with $R < 1$, light's speed is great than its speed in vacuum. So it is not strange that light's speed may be greater than its speed in vacuum at a certain direction if gravitational waves exist.

## 4. Phases Shifts Cannot Be Obtained by the Calculation Method of Time Difference in LIGO Experiments

In classical optics, the difference of time is also used to calculate the change of interference fringes. However, it has a precondition, i.e., light's speed is a constant. LIGO experiments used time differences to calculate the changes of interference images [6] . Due to the fact that light's speed is not a constant when gravitational waves exist, we prove that it is impossible to use time difference to calculate the change of interference fringes. Thought the lengths of interferometer's arms change, the speed of light also changes synchronously, so that the time that light travels along the arms is unchanged too.

Because light's frequency is $\omega = 2\pi\nu = 2\pi c/\lambda$, when gravitational wave exists, if light's speed is unchanged but the wavelength changes, the frequency $\omega$ will change. In this case, (7) should be written as

$$E_x = E_0 \cos\left(\omega_x t - k_x x\right),\ \ E_y = E_0 \cos\left(\omega_y t - k_y y\right) \quad (19)$$

when two lights are superposed, we cannot get (8). The result is related to time and becomes very complex. If light's speed is not a constant, according to (6) and (11), we have

$$\omega_x = 2\pi\nu_x = \frac{2\pi V_x}{\lambda_x} = \frac{2\pi c}{\lambda} = \omega,\ \ \omega_y = 2\pi\nu_y = \frac{2\pi V_y}{\lambda_y} = \frac{2\pi c}{\lambda} = \omega \quad (20)$$

In this case, light's frequency is invariable and the formula (8) is still tenable. So, when gravitational waves exist, we should think that light moves in medium. Light's frequency is unchanged but its speed and wavelength change. Only in this way, we can reach consistency in physics and logic. In fact, (20) is well-found in classical physics. As mentioned in [7] , in a static medium, wave's speed changes but frequency does not change, so wavelength also changes.

We know from (7) that light's phase is determined by both factors $\omega t$ and $kx$. Here $kx = 2\pi x/\lambda$ is an invariable quantity according to discussion above. Because of $\omega = 2\pi\nu = 2\pi/T$ and T is the period of light which changes with t synchronously. We always have $\omega' = 2\pi\nu' = 2\pi t'/T' = 2\pi t/T = \omega$. Because gravitational waves do not affect time t, the phase $\omega t$ of light is also unchanged in LIGO experiments.

## 5. The Problems Existing in the Third Method to Calculate Phase Shifts of Light

There is a more complex method to calculate the phase shift of light for LIGO experiments by considering interaction between gravitational field and electromagnetic field, or by solving the Maxwell's equations in a curved space caused by gravitational wave [8] . This method also has many problems. We discuss them briefly below.

In this calculation, two arms of interferometers are located at the x-axis and the y- axis. If there is no gravitational wave, the vibration direction of electric field is along the y-axis for the light propagating along the x-axis (electromagnetic wave is transverse wave), we have

$$E_y^{(0)} = E_0\left[\mathrm{e}^{i(kx-\omega t)} - \mathrm{e}^{-i(kx-\omega t-2ka)}\right] = -F_{02}^{(0)} \quad (21)$$

Here, a is the coordinate of reflect mirror, $F_{ik}^{(0)}$ is electromagnetic tensor. The form of magnetic field is the same, so we do not write it out here. When the light propagates along the y-axis, the vibration of electric field is along the direction of x-axis with

$$E_x^{(0)} = E_0\left[\mathrm{e}^{i(ky-\omega t)} + \mathrm{e}^{-i(ky-\omega t-2ka)}\right] = -F_{01}^{(0)} \quad (22)$$

Meanwhile, gravitational wave propagates along the z-axis with

$$h_{11} = -h_{22} = -A\cos\left(k_g z - \omega_g t\right) \quad (23)$$

when gravitational wave exists, electromagnetic tensors become

$$F_{\mu\nu} = F_{\mu\nu}^{(0)} + F_{\mu\nu}^{(1)} \quad (24)$$

Here, $F_{\mu\nu}^{(1)}$ is a small quantity of electromagnetic field induced by gravitational field. Substitute (24) in the equation of electromagnetic field in curved space-time, the equation $F_{\mu\nu}^{(1)}$ satisfied is [9] :

$$F_{\mu\nu,\rho}^{(1)}\eta^{\rho\nu} = h_{\mu}^{\nu,\rho}F_{\nu\rho,\rho}^{(0)} + h^{\nu\rho}F_{\mu\nu,\rho}^{(0)} + O\left(h^2\right) \quad (25)$$

$$F^{(1)}_{\mu\nu,\rho} = F^{(1)}_{\nu\rho,\mu} + F^{(1)}_{\rho\mu,\nu} = 0 \quad (26)$$

By solving (25) and (26), the concrete form of $F^{(1)}_{\mu\nu}$ can be obtained and the phase shifts caused by gravitational waves can be determined. The phase shifts along two arms are [8]

$$\delta\varphi_x = \frac{A}{2}\frac{\omega}{\omega_g}\sin\omega_g\tau, \quad \delta\varphi_y = -\frac{A}{2}\frac{\omega}{\omega_g}\sin\omega_g\tau \quad (27)$$

The total phase shift between two arms is $\delta\varphi = \delta\varphi_x - \delta\varphi_y$. However, by careful analysis, we find following problems in this calculation.

1) This method is also based on the precondition that light's speed is unchanged. As proved above, this is impossible.

2) Because the phases of lights are not affected by gravitational waves, the forms of (21) and (22) are invariable when gravitational waves exist. We have $F^{(1)}_{\mu\nu} = 0$ in (24), no phase shifts of lights can be obtained by this calculating method.

3) According to (21) and (22), the vibration directions of two lights propagating along the x-axis and the y-axis are vertical, so they cannot interfere to each other. How did gravitational waves make the shifts of interference fringes? This is another basic problem for this calculation method.

In addition, the phase differences $\delta\varphi_x$ and $\delta\varphi_x$ caused by gravitational waves cannot be obtained independently and simultaneously by solving Equations (25) and (26). The author of the paper admitted that "we solve these equations in a special orientation which does not correspond to an actual interferometer arm" [9] . So the paper introduced "a fictitious system which is composed of an electromagnetic wave propagating along the z axis, …is perturbed by a gravitational wave moves along the y-axis." It means that the calculation did not consider the light propagating along another arm of interferometers.

After simplified calculation, a coordinate transformation was used to transform the result to original problem. For the light propagating along the x-axis, the coordinate transformations are $t' = t$ , $x' = y$ , $y' = z$ and $z' = x$ (The coordinate reference frame rotates 90 degrees around the x-axis, then rotates 90 degrees around the z-axis again along the clockwise directions.) For the light propagating along the y-axis, the coordinate transformations are $t' = t$ , $x' = x$ , $y' = z$ and $z' = -y$ (The coordinate reference frame rotates 90 degrees around the x-axis along the anticlockwise direction.). In this way, two problems are caused.

1) When a light propagates along one arm, the interaction between gravitational wave and electromagnetic field is different from that when two lights propagate along two arms, or the formulas (25) and (26) are different in two situations. So this simplified method cannot represent real experiment processes.

2) After coordinate transformation, the electric field of light originally propagating along the x-axis becomes [8]

$$E'^{(0)}_x = E_0\left[e^{i(kz'-\omega t')} - e^{-i(kz'+\omega t'-2ka)}\right] \quad (28)$$

The electric field of light originally propagating along the z-axis becomes

$$E'^{(0)}_x = E_0 e^{2ika}\left[e^{i(kz'-\omega t')} - e^{-i(kz'+\omega t'-2ka')}\right] \quad (29)$$

The gravitational waves become

$$h_{11} = -h_{33} = -A\cos\left(k_g y' - \omega_g t'\right) \quad (30)$$

It is obvious that though the vibration directions of two lights become the same so that the interference fringes can be created, two lights move along the same directions. The process is inconsistent with real experiments of Michelson interferometers. That is to say, it is hard for this calculating method to reach consistence.

In fact, the result of this calculation contracts with the calculation in this paper. The method of this paper is standard one with clear image and definite significance in physics. If the results are different from it by using other methods, we should consider whether or not other methods are correct.

It is obvious that there are so many foundational problems in theory of LIGO experiments. It is meaningless to declare the detection of gravitational waves. Even thought the experiments are moved to space in future, it is still impossible to detect gravitational wave if Michelson interferometers are used.

## 6. Comparison between LIGO Experiment and Michelson-Morley Experiment

The principle of detecting gravitational wave by using Michelson interferometers was first proposed by M. E. Gertenshtein and V. I. Pustoit in early 1960s [8] and G. E. Moss, etc. in 1970s [9] . However, before Einstein put forward special relativity, A. A. Michelson and E.W. Money spent decades to conduct experiments by using Michelson interferometer, trying to find the absolute movement of the earth but failed at last. This result led to the birth of Einstein's special relativity. The explanation of special relativity for this zero result is based on the length contraction of interferometer. When one arm which moved in speed V contracted, another arm which was at rest was unchanged. The speed of light was considered invariable in the process so that no any shift of interference fringes was observed.

It is obvious the principle of LIGO experiment is the same as that in Michelson experiments. Because Michelson's experiments could not find the changes of interference fringes, it is destined for LIGO experiments impossible to find gravitational waves [10] .

We discuss this problem in detail. Suppose that the interferometer's arm is located along the y-axis and the arm along the x axis moves in speed V. For an observer who is at rest with the y-axis, the length contraction and time delay of the arm along the x-axis are

$$x' = x\sqrt{1-V^2/c^2}, \quad t' = t\big/\sqrt{1-V^2/c^2} \tag{31}$$

Suppose that the period is $T'$ and the frequency is $\nu'$ for a light moving along the x-axis, we have $\nu'T' = 1$, $\omega' = 2\pi\nu' = 2\pi/T'$, as well as $T' = T\big/\sqrt{1-V^2/c^2}$ (period is also time). So we have

$$\omega't' = \frac{2\pi t'}{T'} = \frac{2\pi t}{T} = \omega t, \quad k'x' = \frac{2\pi x'}{\lambda'} = \frac{2\pi x}{\lambda} = kx \tag{32}$$

It means that in the rotation processes of Michelson interferometers, the phase $\omega t - kx$ of light is unchanged. In this way, the absolute movement of the earth cannot be observed. The key is that light's speed is unchanged, frequency and wavelength change simultaneously in the processes. But in LIGO experiment, as shown in (2), (3) and (17), due to the fact that the time part of metric is flat but space is curved, light's speed and wavelength had to change when gravitational waves exist. This is just the difference between LIGO experiments and Michelson experiments. But the phases of lights are invariable in both experiments. We can only obtain zero results, so LIGO experiments are destined failed to find gravitational waves.

Let's make further calculation. The speed that the earth moves around the sun is $V = 3\times10^4$ m/s. The length of Michelson interferometer's arm is $L = 10$ m. According to special relativity, the Lorentz contraction of one arm in Michelson experiments is

$$\Delta L = L\left(1-\sqrt{1-V^2/c^2}\right) = L\times V^2\big/\left(2c^2\right) = 5\times10^{-8}\ \text{m} \tag{33}$$

In LIGO experiment, the length change of arm is about $10^{-18}$ m, about one 20 billionth times smaller than that in Michelson experiment. Suppose that the shift of interference fringes can be observed in Michelson experiments. According to classical mechanics, the number of fringe shifts is about 0.2. Suppose that IGO

experiments can detect the shift of interference fringes caused by gravitational waves, the number of fringe shifts is only one 100 billionth of Michelson experiment. How could LIGO experiments separate such small shifts from strong background noises of environment (including temperature influence) and identified that they were really the effect of gravitational waves?

In fact, LIGO's interferometers are fixed on two huge steel tubes with length 4000 m. The steel tubes are fixed on the surface of the earth under wind and rain. It is impossible to put so huge interferometers in a constant temperature rooms. The tubes are displaced vertically and 4000 m is not an ignorable length. The differences of temperatures exist and change with time frequently. Suppose that at a certain moment, the temperature of one tube changes 0.001 degree in one second. This is a conservative estimation. We calculate its influence on LIGO's experiment.

The expansion coefficient of common steel tube is $1.2 \times 10^{-5}$ m/degree. When temperature changes 0.001 degree, the change of tube length is $1.2 \times 10^{-5} \times 0.001 \times 4000 \approx 5 \times 10^{-5}$ m in one second. The action time of gravitational wave is 1 second. In this time, the length change of tube caused by gravitational wave is $10^{-18}$ m. The length change of tube caused by gravitational wave only is $2 \times 10^{-12}$ times less than that caused by the change of temperature.

What is this concept? It means that LIGO used a ruler of 10 Km to measure the radius of an atom. The length changes caused by temperature completely cover up the length changes caused by gravitational waves. No any reaction can be found when a signal of gravitational wave hit the interferometers of LIGO. LIGO's instrument cannot separate the effect of gravitational waves from temperature's effect. The SNR (signal to noise ratio) of 13 and 24 declaimed by LIGO is only an imaginary value in theory, having nothing to do with practical measurements.

## 7. Conclusions

In this paper, based on general relativity, we strictly prove that the LIGO experiments neglect two factors. One is the effects of gravitational waves on the wavelengths of light. Another is that light's speed is not a constant when gravitational waves exist. If these factors are considered, no phase shifts or interference fringe's changes can be observed in LIGO experiments by using Michelson interferometers.

In fact, in the laser detectors of gravitational waves, Gaussian beams are commonly used. The propagation speed of Gaussian beam is not a constant too. So the match of signals becomes a big problem without considering these factors in LIGO experiments.

In addition, in Reference [5] , X. Mei and P. Yu pointed out that no source of gravitational wave burst was found in LIGO experiments. The so-called detections of gravitational waves were only a kind of computer simulation and image matching. LIGO experiments had not verified general relativity. The argument of LIGO team to verify the Einstein's prediction of gravitational wave was a vicious circle and invalid in logic. The method of numerical relativity to calculate the binary black hole mergers was incredible because too many approximations were involved.

In Reference [11] , P. Ulianov indicated that the signals appeared in LIGO experiments may be caused by the changes of frequency in the US power grid. The analysis shows that one of noise sources in LIGO's detectors (32.5 Hz noise source) is connected to the 60 Hz power grid and at GW150914 event. This noise source presents an unusual level change. Besides that, the 32.5 Hz noise waveform is very similar to the gravitational waveform, found in GW150914 event. As LIGO system only monitored the power grid voltage levels without monitoring the 60 Hz frequency changes, this kind of changes over US power grid (that can affect both LIGO's detectors in a same time windows) was not perceived by the LIGO team.

Based on the arguments above, we can conclude that it is impossible for LIGO to detect gravitational waves. What they found may be some noises by some occasional reasons. So called finding of gravitational waves is actually a game of computer simulations and image matching, though it is a very huge and accurate game.

## Conflicts of Interest

The authors declare no conflicts of interest.

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